



LEGIONELLA ENVIRONMENTAL HAZARD RECOGNITION AND MITIGATION

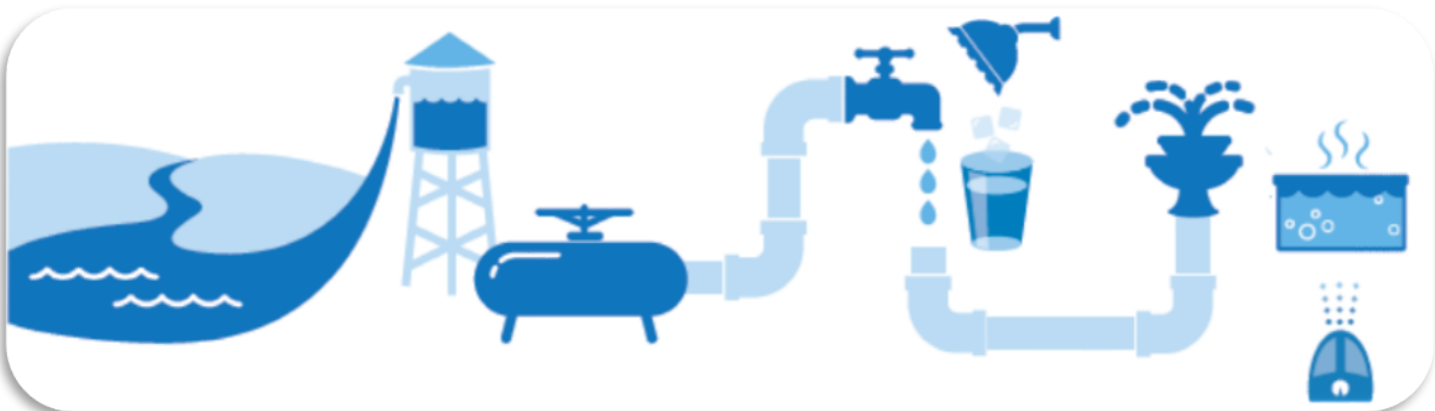
Engineering, Controls, and Specialized Equipment





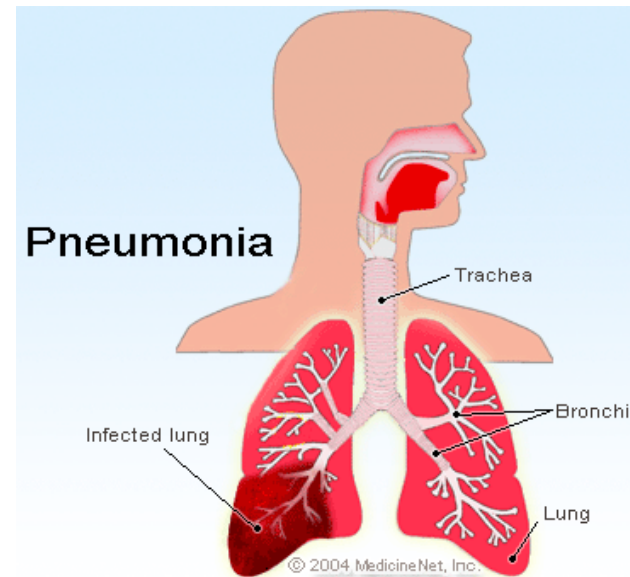
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- We need to manage the complete water system

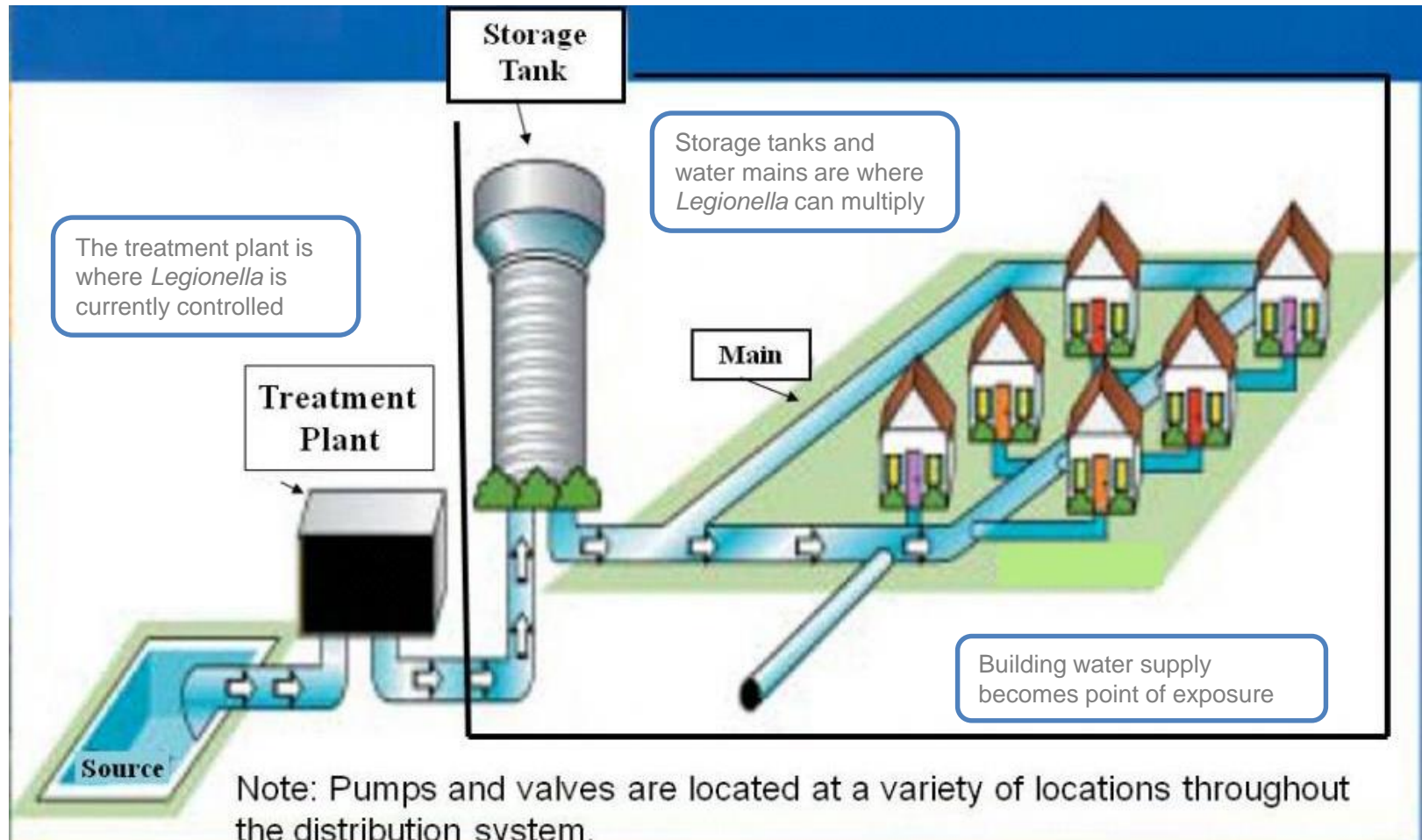


LEGIONNAIRES' DISEASE

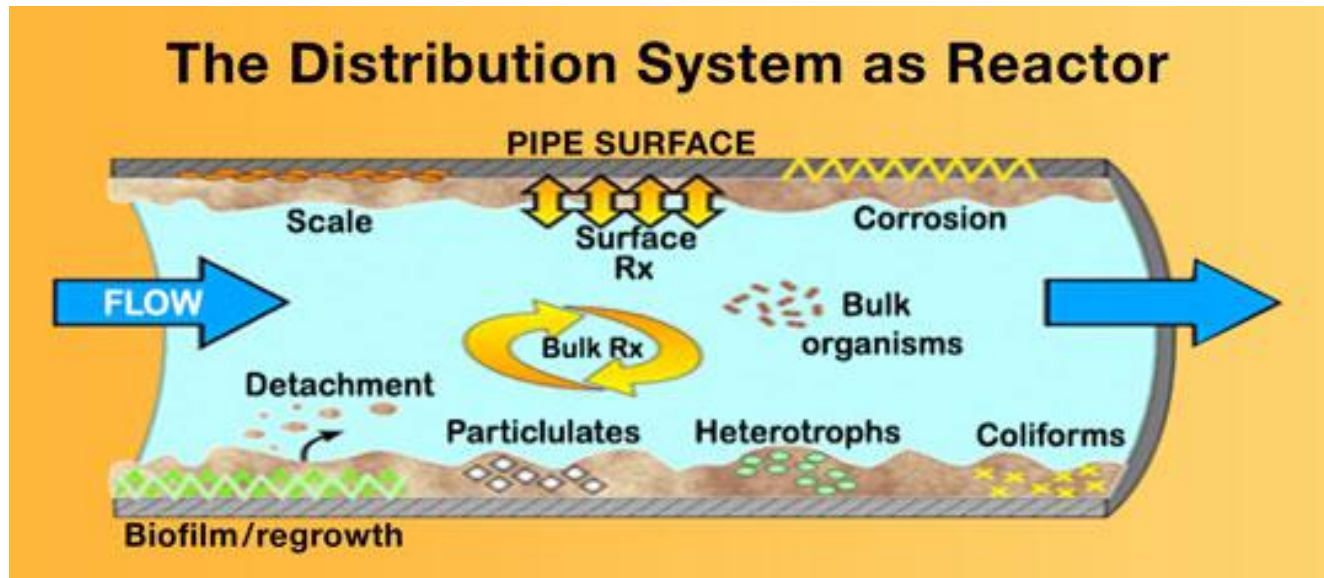
- 96% of all cases of Legionnaires Disease are individual, sporadic cases
- 4% of all cases of Legionnaires Disease are from outbreaks.



TYPICAL WATER DISTRIBUTION SYSTEM

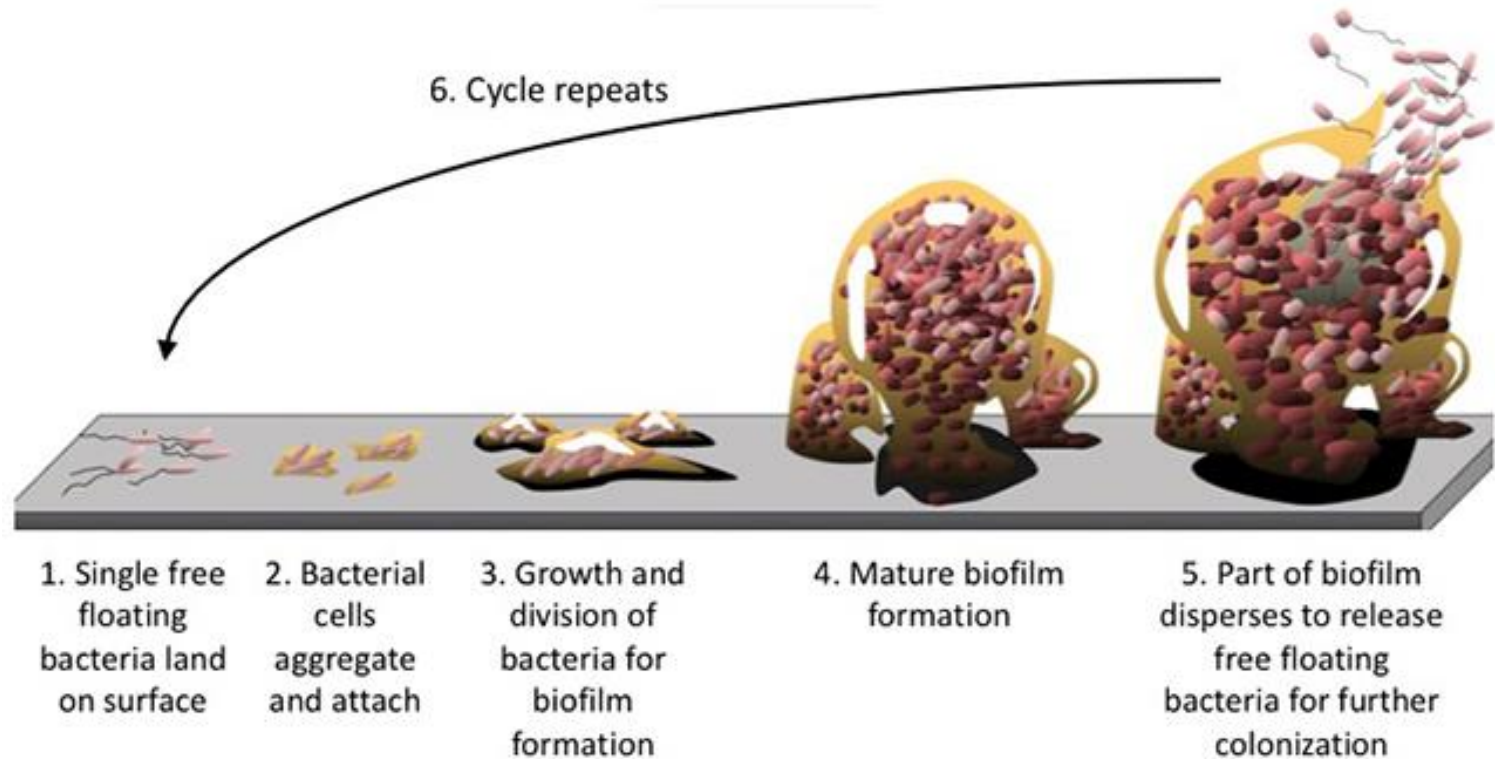


THE DRINKING WATER ECOSYSTEM



Source: University of Montana Center for Biofilm Engineering

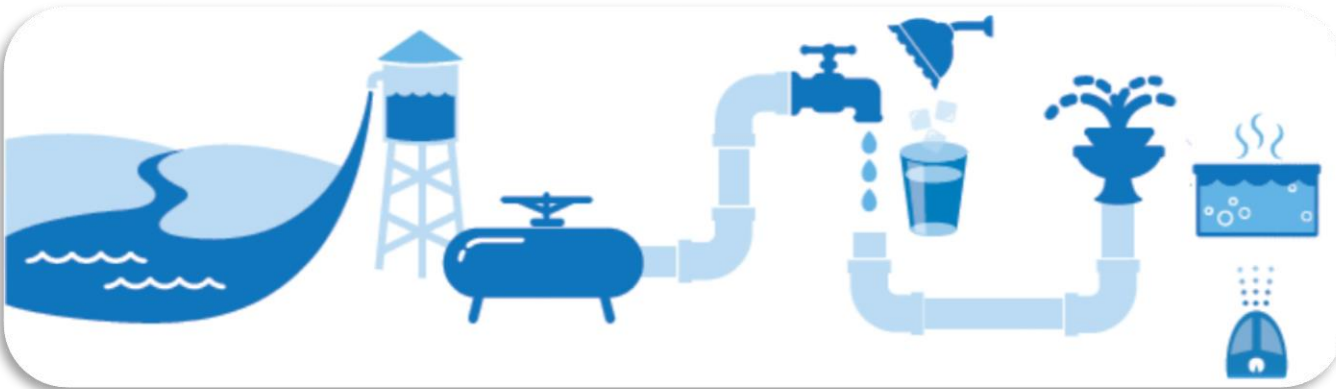
BIOFILM ACTIVITY



LEGIONELLA BACTERIA GROWTH AND EXPOSURE

Legionella is found in source water and can **MULTIPLY** in the public drinking water distribution system

Bacteria **ENTER** dwellings with the public drinking water and can proliferate in building water systems (storage tanks and building water distribution system)



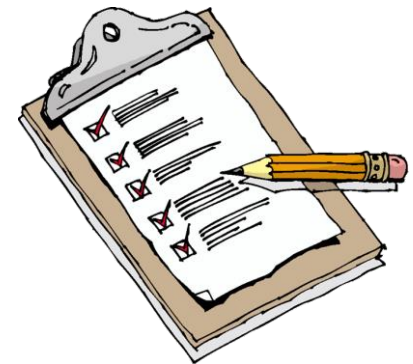
Bacteria live in the biofilm and can be **RELEASED** when disrupted by maintenance, water main breaks, pressure surges, or fire hydrant use

Bacteria can be **DISSEMINATED** from many water sources

CONTROLLING LEGIONELLA IN BUILDING SYSTEMS

MOST IMPORTANT:

- Eliminate “dead-legs” and other stagnation
- Stagnation = 16 hours
- Limit distances from HW recirculation loop
- Low flow fixtures: how low is low enough?
- Perform regular system flushing
 - Electronic fixtures, solenoid valves
 - Manual flushing
- Temperatures over 122°F inhibit growth
- TEST TEST TEST!
- DOCUMENT DOCUMENT DOCUMENT!



ADDITIONAL METHODS OF CONTROL

Increased Hot Water Temperatures

- Recirculate greater than 140°F
- Periodic heat sanitizing (over 158°F)
 - Simple
 - Effective on free-floating *Legionella*
 - Dead legs - Stagnation
 - Scald risk
 - Mixing valves (GROWTH!)
 - Energy wasted
 - Hot water limitations?
 - Doesn't kill within biofilm

Below 20°C	(68°F)	Can survive but are dormant
20 to 50°C	(68 to 122°F)	Growth rate
35 to 46°C	(95 to 115°F)	Ideal growth range
Above 50°C	(122°F)	Can survive but do not multiply
55°C	(131°F)	Dies within 5-6 hours
60°C	(140°F)	Dies within 32 minutes
66°C	(151°F)	Dies within 2 minutes
70 to 80°C	(158 to 176°F)	Disinfection range

Temperature doesn't deal with the "cold" water lines or "mixed" fixture outlets.
DEAD CELLS = FOOD!!!

ADDITIONAL METHODS OF CONTROL

Chemical Disinfectants

- Differing levels of effectiveness
- Community water certification required
- Can attack plumbing systems (metals, rubbers, etc.)
- Regular maintenance requirements
 - Chemical replenishment
 - Replacement/cleaning of pumps, probes, elastomers, etc.



CHEMICAL DISINFECTANTS

- **Monochloramine** (1 - 1.4 PPM residual – hot water only!)
- Currently most recommended chemical
- Good results with biofilm control and penetration
- Long-lasting residual
- Can be combined with city-provided chlorine/chloramine
- Attacks rubber
- Nitrification (nitrates = regulated)
- Over-feed can cause significant damage to piping (especially copper)



CHEMICAL DISINFECTANTS

🌿 Chlorine Dioxide (ClO₂)

- 🌿 (0.4 - 0.7 PPM dose, 0.1 - 0.5 PPM residual)
- 🌿 Good control of free-floating *Legionella*
- 🌿 Mixed results with biofilm and amoeba
- 🌿 Flammable and explosive (often on contact)
- 🌿 Toxic off-gas (filtration required)
- 🌿 Chlorite buildup (regulated)



Take care when mixing different disinfectants!

CHEMICAL DISINFECTANTS

Free Chlorine (0.5 – 1.0 PPM free residual)

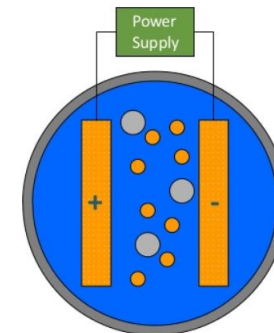
- Inexpensive (bleach)
- Commonly used and understood
- Can help with free-floating bacteria
- Oxidizes metals (especially in high pH)
- Degrades in high temperatures
- Ineffective on biofilms and amoeba
- Byproducts (regulated)



ADDITIONAL METHODS OF CONTROL

Copper Silver Ionization

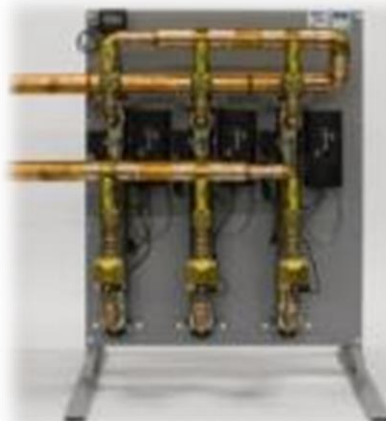
- Very effective on free-floating Legionella
- Decent biofilm penetration
- pH limitations (ineffective in high pH)
- Potential increase in Mycobacterium, per USEPA study
- Regulated metals released into water
 - Weekly testing/maintenance
- Metal buildup in system
- Classified as "insecticide"



ADDITIONAL METHODS OF CONTROL

UV Irradiation

- Very high kill rate for Legionella + Amoeba
- Simple and inexpensive
- Requires direct contact with water
- Destroys chlorine
- Particulates = incomplete disinfection
- Dead bacteria = FOOD!



ADDITIONAL METHODS OF CONTROL

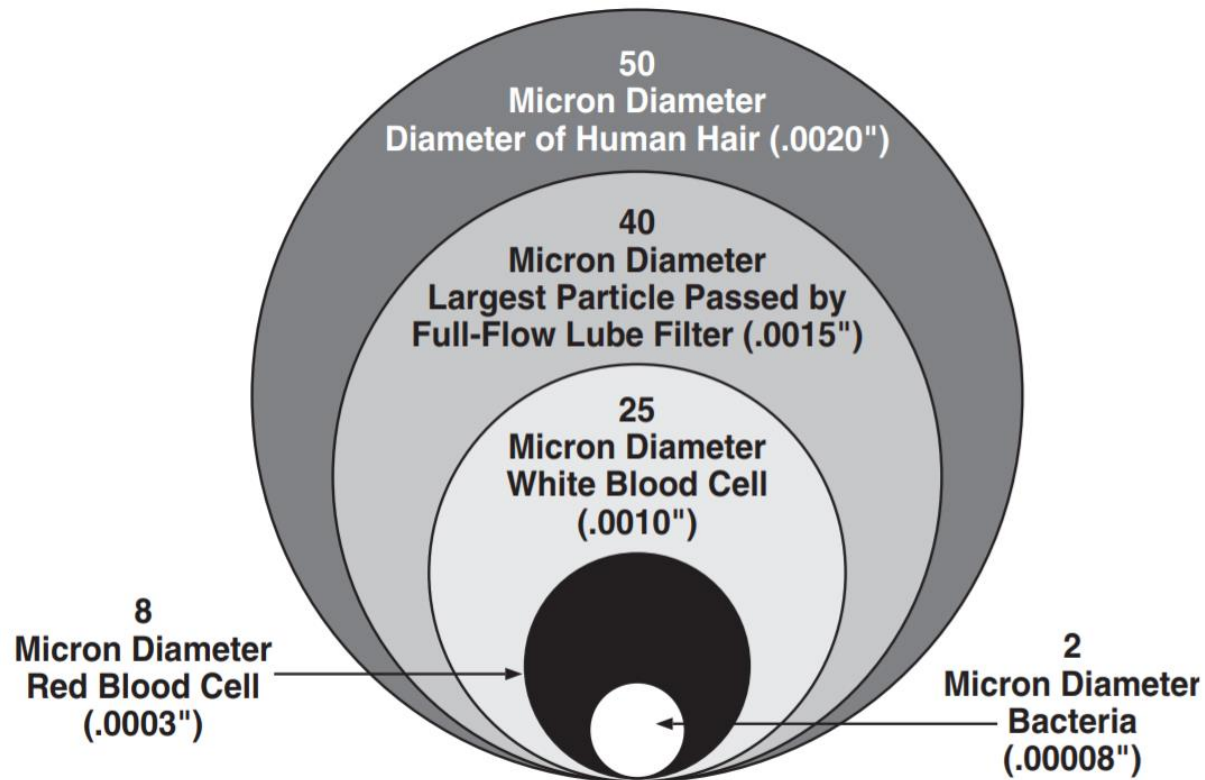
Pervasive Electronics

- Very high kill rate for all bacteria (including biofilm)
- Simple and inexpensive
- No maintenance and low operating costs
- Requires constant power and signal generation
- Limited signal to move through piping system
- Formation of precipitant
- Dead bacteria = FOOD!

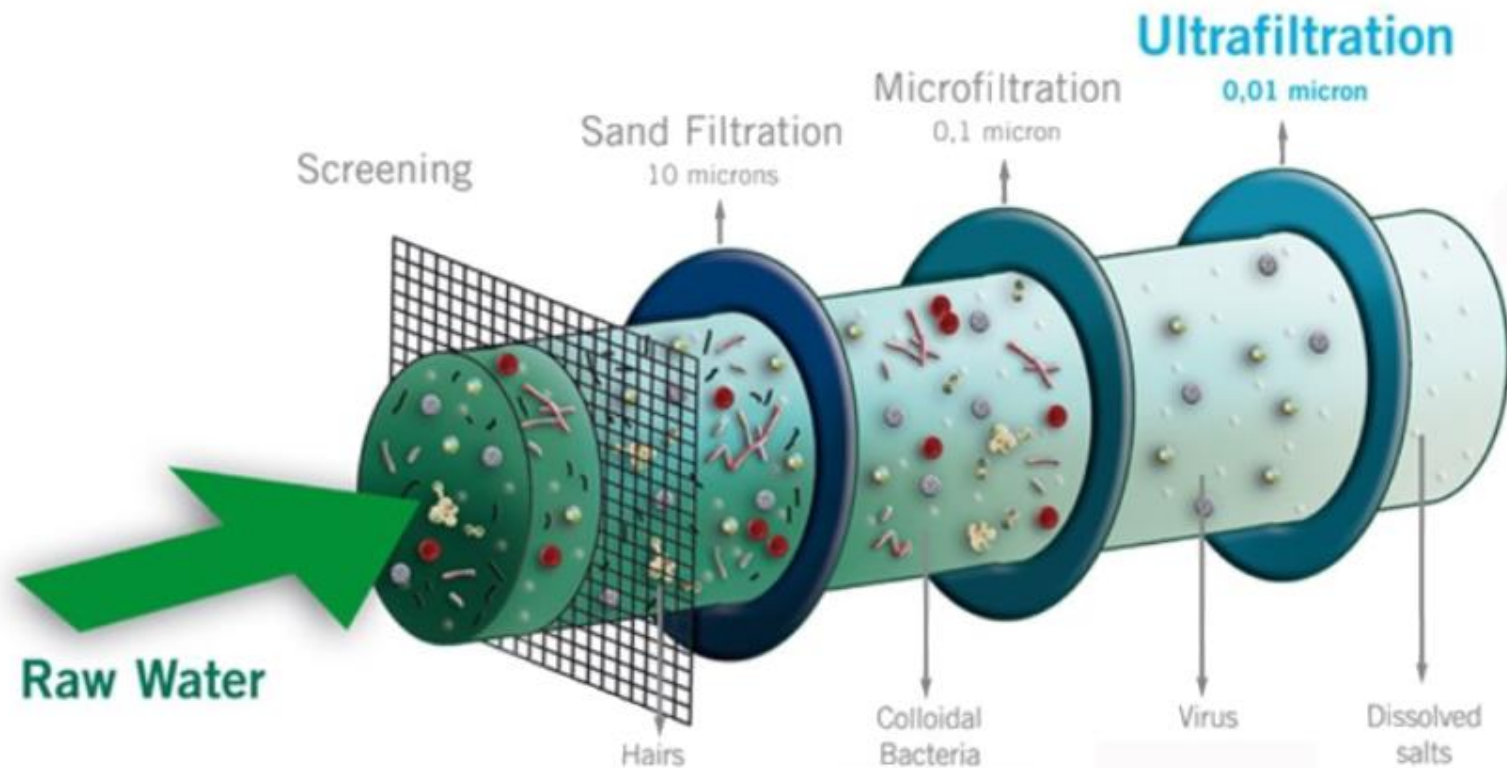


ADDITIONAL METHODS OF CONTROL

Barrier Filtration

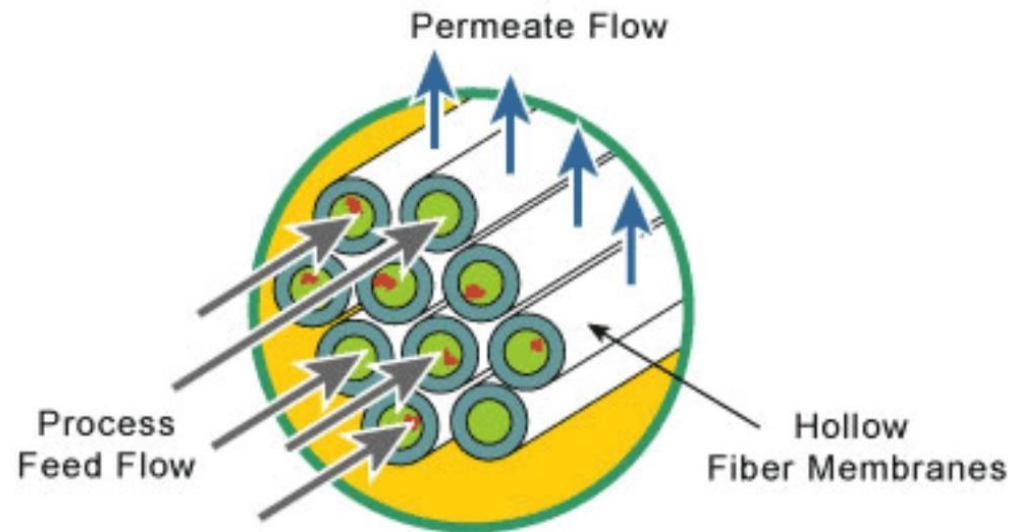


BARRIER FILTRATION



BARRIER FILTRATION

Hollow Fiber Membrane Technology



BARRIER FILTRATION

Hollow-Fiber Filtration

- Point-of-use filtration, up to 30 GPM
- Filtration to 0.1
- Highly effective
- Good emergency solution
- Expensive
- Maintenance-intense (up to 6-month life)
- Increased bacteria upstream of filter



BARRIER FILTRATION

Ultra-Filtration

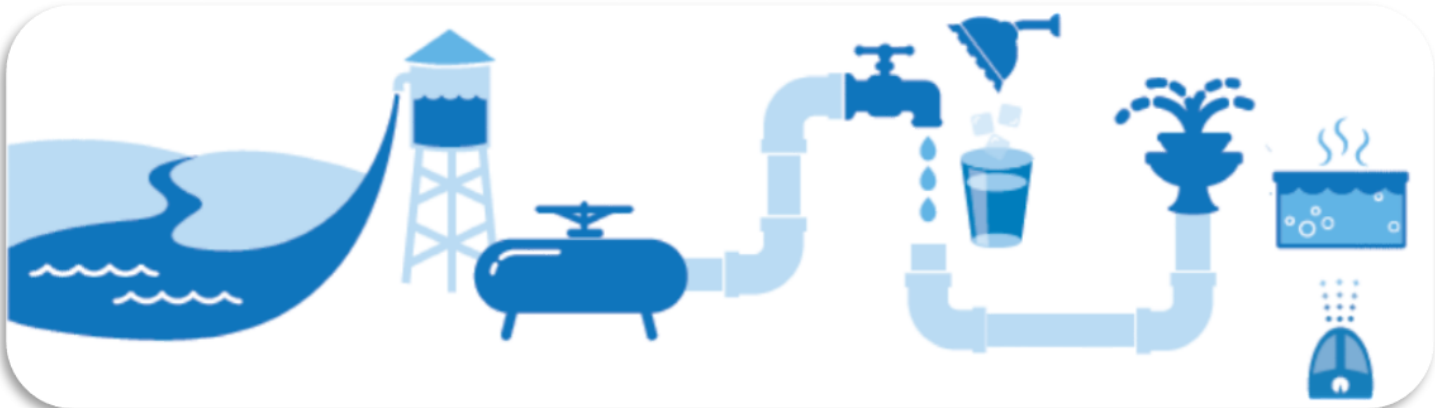
- Point-of-entry filtration, self-cleaning
- Filtration to 0.01 micron
- Protects the entire system downstream
- 99.99% removal of bacteria, amoeba, viruses
- Expensive
- Redundancy required for back-wash





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- Helping to make our water systems a priority!





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